EXHIBIT B

UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA

In Re Tesla, Inc. Securities Litigation	Case No. 18-CV-04865 (EMC)

EXPERT REBUTTAL REPORT OF PROFESSOR AMIT SERU

DECEMBER 8, 2021

I. QUALIFICATIONS

1. I am the Steven and Roberta Denning Professor of Finance at the Stanford Graduate School of Business, a Senior Fellow at the Hoover Institution and Stanford Institute for Economic Policy Research (SIEPR), a Research Associate at the National Bureau of Economic Research (NBER), and a Research Fellow at the Center for Economic Policy Research (CEPR). Before moving to Stanford, I was a Dennis and Karen Chookaszian Professor at the University of Chicago's Booth School of Business. I was a faculty member at the University of Chicago from 2007 to 2016.

2. I hold a Ph.D. in Finance, awarded in 2007 by University of Michigan. In addition, I received my B.E. (Bachelor of Engineering), with concentration in Electronics, from the University of Delhi in 1996 and my MBA from the University of Delhi in 1998.

3. I am a co-editor at the Journal of Finance, the official publication of The American Finance Association. The Journal of Finance publishes leading research across all major financial research fields and is one of the most widely cited academic journals in finance and economics. I was also a former editor of both Management Science and the Review of Corporate Finance Studies. I have also served as associate editor of the Journal of Political Economy, Journal of Finance, Management Science, and the Journal of Financial Intermediation. I have received various National Science Foundation (NSF) grants and was named as one of the top 25 Economists under 45 by the International Monetary Fund in 2014. Most recently I received the Alexandre Lamfalussy senior research fellowship from the Bank for International Settlement (BIS) related to my work on intermediation by fintech and big tech firms.

4. My primary research interest is in corporate finance, specifically issues related to financial intermediation and regulation, interaction of internal organization of firms with financing and investment, and incentive provision in firms. As detailed in my curriculum vitae, I have authored or co-authored more than 30 published peer-reviewed scholarly articles in top economics and finance journals, including the American Economic Review, the Quarterly Journal of Economics, the Journal of Political Economy, the Review of Economic Studies, the Journal of Finance, the Journal of Financial Economics, and the Review of Financial Studies. I have presented my research to U.S. and international regulatory agencies, including the SEC, the Fed, FDIC, CFPB, FINRA, ECB, and BIS. My research has also been featured in major media, including the Wall Street Journal, the New York Times, the Financial Times, and the Economist.

5. I have taught basic and advanced finance and corporate governance courses covering asset pricing and options to MBA students and executives at both Stanford and Chicago for more than a decade. In addition, I have taught several advanced empirical finance research classes to Ph.D. students at both Stanford and Chicago that have covered elements of options and derivatives. As discussed above, my research has touched on several issues in finance and economics, including studies on valuation of asset backed securities, patents that are related to topic of market efficiency, and valuation of option-like payoffs.

6. I have previously served as an expert witness in litigation, addressing issues related to market efficiency and damages. A copy of my curriculum vitae, which provides additional details of my professional background, including my publications, is attached as **Appendix A**. A list of my expert witness work as well as deposition testimony is also included in **Appendix A**.

II. ASSIGNMENT AND SUMMARY OF CONCLUSIONS

7. I have been asked by counsel for the Defendants in the above captioned matter to (1) evaluate Professor Heston's proposed methodology for estimating damages to option holders and (2) evaluate Dr. Hartzmark's analysis of the implied volatility of a particular option portfolio to estimate the inflation as a result of the "direct" effect of Mr. Musk's tweet during the class period.[1]

8. I reached the following conclusions:

- Professor Heston's methodology for estimating damages to Tesla option holders is fundamentally flawed for the following reasons, each of which makes it unreliable:
  - The Black-Scholes model is neither reliable nor appropriate when a company is involved in a merger or acquisition deal;
  - Professor Heston's assumption of put-call parity is not supported by the academic literature and does not hold for Tesla stock during the class period;
  - Professor Heston's assumption of constant implied volatility across options is speculative, unreliable, inaccurate, and not supported by the academic literature; and
  - Professor Heston's methodology fails to use actual prices in the actual world to measure damages and consequently fails to reliably estimate the

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[1] Expert Report of Steven L. Heston, Ph.D., dated November 8, 2021 ("Heston Report"); Expert Damages Report of Michael L. Hartzmark, Ph.D., dated November 10, 2021 ("Hartzmark Report"). "It is further my understanding that the Class Period: (a) begins on August 7, 2018 at 12:48 p.m. EDT when Mr. Musk tweeted 'Am considering taking Tesla private at $420. Funding secured.'; and (b) ends on August 17, 2018, after the publication of a New York Times article." Heston Report, ¶9.

difference between actual and but-for prices, and his justification for this assumption is unsubstantiated, speculative, and incorrect as a matter of fact.

- As a consequence of these flaws, Dr. Hartzmark's implementation of Professor Heston's methodology is speculative, unreliable, and inaccurate and would allocate damages to option holders that were not damaged.

- Dr. Hartzmark's use of the January 2020 at-the-money forward straddle[2] to estimate how the probability of deal completion and the "direct" effect of Mr. Musk's tweet changed over the class period is arbitrary and fundamentally flawed for the following reasons:

  - Dr. Hartzmark's assumption that all movements in implied volatility throughout the class period are due to changes in the "direct" effect of Mr. Musk's tweet is fundamentally flawed; and

  - Dr. Hartzmark's choice to analyze the implied volatility of the January 2020 at-the-money forward straddle is arbitrary, and his results are not robust against reasonable alternatives.

9. I elaborate on and provide the bases for my opinions in Sections IV and V of this report. In performing this work, I have received assistance from Compass Lexecon personnel working under my supervision. Compass Lexecon is being compensated for the time spent by Compass Lexecon personnel at their customary hourly rates. My current hourly rate is $1,000. My compensation is not contingent on the analyses we conducted or the opinions I offer in this

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[2] Options are "at-the-money when the spot price equals the strike price." At-the-money can be abbreviated as "ATM." A straddle is an option portfolio "when an investor buys both a call and put option of the same underlying asset, each with the same strike price and expiry date." Further, an "ATM forward straddle, as opposed to a simple ATM straddle, means the forward (rather than spot) price equals the strike for both option positions in the straddle." Heston Report, ¶¶21, 73, 80.

report. A list of materials I have considered in connection with the preparation of this report is attached as **Appendix B**.

III. PROFESSOR HESTON'S METHODOLOGY FOR ESTIMATING DAMAGES TO TESLA OPTION HOLDERS IS FUNDAMENTALLY FLAWED FOR SEVERAL REASONS, EACH OF WHICH MAKES IT UNRELIABLE

10. Professor Heston uses the following method to calculate damages[3]:

> Step 1: Calculate "Actual Implied Volatility" by finding the price of the at-the-money forward straddle with the same expiry and transaction date as the option in question and using the Black-Scholes model to calculate the implied volatility of this straddle.
>
> Step 2: Calculate a "Re-Valued Fitted Option Value", using the Black-Scholes model with the Actual Implied Volatility and the actual Tesla stock price to value the option in question.
>
> Step 3: Calculate a "But-For Fitted Option Value" by using the Black-Scholes model with the but-for Implied Volatility and the but-for Tesla stock price to value the option in question.
>
> Step 4: The "Impact Quantum" for the option in question is defined to be the difference between Re-Valued Fitted Option Value and But-for Fitted Option Value.

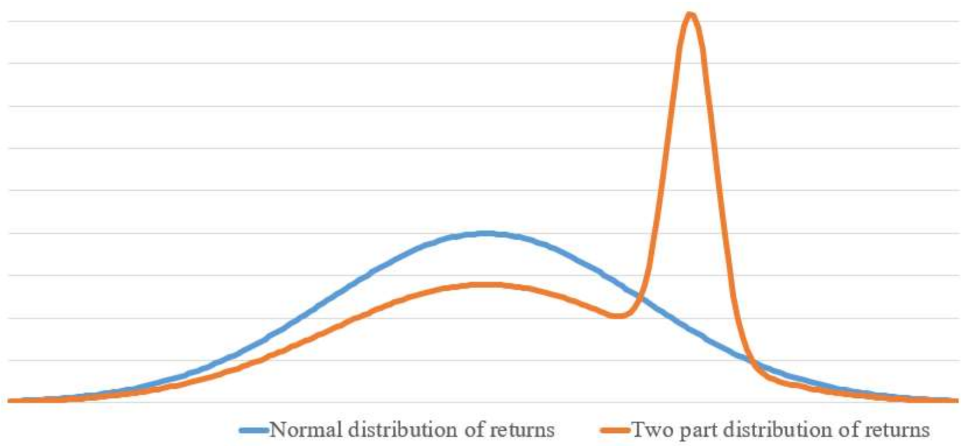
11. Professor Heston's methodology for estimating damages to Tesla option holders is fundamentally flawed for several reasons, which I describe below, each of which makes it unreliable. As a consequence of these flaws, Dr. Hartzmark's implementation of Professor Heston's methodology is speculative, unreliable, and inaccurate and would allocate damages to option holders that were not damaged.

[3] Heston Report, ¶165.

A. Black-Scholes model is neither reliable nor appropriate when a company is involved in a merger or acquisition deal

12. The Black-Scholes model assumes that the distribution of stock prices is lognormal and the resulting distribution of future stock price returns is bell-shaped. However, as Dr. Hartzmark explains, the distribution of Tesla's stock price following Mr. Musk's tweet is composed of two parts – a single deal price with a given probability and a stock price distribution if the deal is not completed.[4] Therefore, the distribution of stock prices is not lognormal. And consequently, the distribution of future stock price returns is not bell shaped. In **Figure 1** below I show a stylized difference in stock price returns between these two situations.[5]

Figure 1: Difference between a normal distribution of returns and a two-part distribution of returns



13. Academic researchers have developed option pricing models that apply to companies involved in a merger or acquisition deal. For example, Bester et al. (2021) "study

[4] Hartzmark Report, p. 124. Professor Heston explains, citing literature, that "the Black–Scholes implied volatility decreases when the deal is close to being successful: a success probability close to one leads to an implied volatility close to zero." Heston Report, ¶134.

[5] As Mr. Musk had previously discussed taking Tesla private, the distribution of Tesla's stock price returns before Mr. Musk's tweet would also have incorporated multiple components. *See, e.g.*, "Elon Musk: The architect of tomorrow," Rolling Stone, November 15, 2017.

both theoretically and empirically option prices on firms undergoing a cash merger offer."[6] They develop a model that is "well suited to study cash mergers, which are difficult to analyze with other models of option pricing."[7] Their model improves on the mispricing inherent in the Black-Scholes model and that this mispricing "depends crucially on the probability of success of the cash merger" which, according to Mr. Hartzmark, meaningfully changes over the class period from 36 percent at market close on August 7 to zero at market close on August 17.[8] Specifically, Bester et al. (2021) state:[9]

> A simple but stark implication of the model is that the implied volatility curve for the target of a cash merger must exhibit a kink (*i.e.*, difference in slopes) at the merger offer price, if the expiration date arrives after the effective date. Indeed, a call option on a cash amount (the offer price) pays either the difference between that amount and the strike price if this difference is positive, or pays zero if the difference is negative. Moreover, the magnitude of the kink (difference in slopes) is proportional to the success probability of the merger.
>
> We verify this implication by considering all cash mergers announced between January 1996 and December 2014 that have call options traded daily on the target firm. … [W]e show that the shape of the volatility curve depends crucially on the probability of success of the cash merger…
>
> [W]e compare the model-implied option prices to the ones that arise from the [Black-Scholes] formula, and we find that our formula performs significantly better for call prices: the average percentage error is 9.39% for our model compared with an error of 19.49% in the case of the [Black-Scholes] model.

14. Other academic research has similarly shown, both theoretically and empirically, that Black-Scholes model is neither reliable nor appropriate when a company is involved in a

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6 Bester, C. Alan, Victor H. Martinez, and Ioanid Rosu (2021): "Option Prices and the Probability of Success of Cash Mergers," *Journal of Financial Econometrics*.

7 Bester, C. Alan, Victor H. Martinez, and Ioanid Rosu (2021): "Option Prices and the Probability of Success of Cash Mergers," *Journal of Financial Econometrics*, at 6.

8 Hartzmark Report, pp. 125, 132, 135.

9 Bester, C. Alan, Victor H. Martinez, and Ioanid Rosu (2021): "Option Prices and the Probability of Success of Cash Mergers," *Journal of Financial Econometrics* at 2, 3, 6.

merger or acquisition deal. I describe two such efforts. Subramanian (2004) "develop[ed] an arbitrage-free and complete framework to price options on the stocks of firms involved in a stock-for-stock merger or acquisition deal allowing for the possibility that the deal might be called off at an intermediate time, creating discontinuous impacts on the stock prices. … The results of tests indicate that the model performs significantly better than the Black–Scholes model in explaining observed option prices."[10] Barone-Adesi et al. (1994) analyzed 65 tender offers and found that "traders effectively shorten the life of options scheduled to expire beyond the resolution date of the tender offer by setting their prices so as to reduce the implied stock volatility below its normal level. Further, [they] also demonstrated that this reduction became significantly greater as the time to the actual resolution date drew shorter."[11]

15. As a consequence of these flaws, Dr. Hartzmark's implementation of Professor Heston's methodology is speculative, unreliable, and inaccurate in allocating damages to option investors based on a model that is neither reliable nor appropriate for this situation.

B. Professor Heston's assumption of put-call parity is not supported by the academic literature and does not hold for Tesla stock during the class period

16. Professor Heston claims that "put-call parity holds for ATM options" and that he "can consequently use ATM-forward straddle prices to calculate implied volatility."[12] This claim

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10 Subramanian, Ajay (2004): "Option Pricing on Stocks in Mergers and Acquisitions," *Journal of Finance* 59(2), 795-829.

11 Barone-Adesi, Giovanni, Keith C. Brown, and W.V. Harlow (1994): "On the Use of Implied Volatilities in the Prediction of Successful Corporate Takeovers," *Advances in Futures and Options Research* 7, 147-165 at 162.

12 Heston Report, ¶128.

is unsupported both by the academic literature and by empirical analysis of Tesla options during the class period.

17. Kamara and Miller (1995) note that "existing empirical studies of the put-call parity condition report frequent, substantial violations."[13] In contrast, Professor Heston assumes that put-call parity generally holds for any set of options he chooses to analyze; and he does not discuss empirical violations of put-call parity outside of unusual situations.[14]

18. Cremers and Weinbaum (2010) find that there are deviations from put-call parity and that they "contain information about future stock returns."[15] In contrast, Professor Heston and Dr. Hartzmark assume that they can infer information about future stock returns from changes in implied volatilities over time while assuming that put-call parity holds.

19. Research has also shown that deviations from put-call parity can occur in the presence of short sale constraints on the underlying stocks, such as high borrowing costs.[16] Although Tesla was a highly shorted stock before and during the class period,[17] it was also one of the costliest stocks to short.[18]

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[13] Kamara, Avraham and Thomas W. Miller, Jr. (1995): "Daily and Intradaily Tests of European Put-Call Parity," *Journal of Financial and Quantitative Analysis* 30(4), 519-539.

[14] Heston Report, ¶58.

[15] Cremers, Martijn and David Weinbaum (2010): "Deviations from Put-Call Parity and Stock Return Predictability," *Journal of Financial and Quantitative Analysis* 45(2), 335-367.

[16] Cremers, Martijn and David Weinbaum (2010): "Deviations from Put-Call Parity and Stock Return Predictability," *Journal of Financial and Quantitative Analysis* 45(2), 335-367.

[17] *See, e.g.*, Hartzmark Report, footnote 41.

[18] In 2016, the cost of borrowing Tesla shares in order to short them was as high as 120 percent, or 0.5 percent per day, *see* "Tesla's Short Squeeze Unwinds as Borrowing Costs Fall," Wall Street Journal, September 28, 2016. In March 2018, the cost of borrowing Tesla shares continued to be elevated above general rates, *see* "Tesla is heavily shorted across the capital

20. Deviations from put-call parity are also evident in the option pricing data Professor Heston used in his calculations. For example, **Exhibit 1** shows implied volatility of Tesla put and call options with expirations in January 2020 based on the Black-Scholes model, the options that Dr. Hartzmark used to calculate the difference between "direct" and "consequential" inflation[19] and that Professor Heston highlighted in his Figures 18, 19, 20, 21, and 23.[20] If put-call parity held, the put and call options with the same strike price and expiration date would have the same implied volatility. As evident in the exhibit, this is not the case for August 6, before Mr. Musk's tweet, nor for August 8, after Mr. Musk's tweet and during the class period.[21] See **Exhibit 2**.

21. As a consequence of these flaws, Dr. Hartzmark's implementation of Professor Heston's methodology is speculative, unreliable, and inaccurate in allocating damages to option investors based on assumptions that do not hold.

C. Professor Heston's assumption of constant implied volatility across options is unfounded and not supported by the academic literature

22. Professor Heston's methodology calculates implied volatility for a portfolio of at-the-money options and then uses this implied volatility to value a wide range of call and put options.[22] However, it is well known in the economic literature that implied volatility is not

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structure," IHS Markit, March 26, 2018. In May 2018, the cost of borrowing Tesla shares increased further, *see* "Musk's conduct, Tesla stock slide make $700 million profit for short-sellers," Reuters, May 3, 2018.

[19] Hartzmark Report, p. 132.

[20] Heston Report, pp. 49-55.

[21] Implied Volatility is calculated using the Black-Scholes model. I use the same parameters that Dr. Hartzmark uses in his calculations of "Re-Valued Fitted Option Value" in Appendix 8 and as described in footnote 322 of the Hartzmark Report.

[22] Heston Report, ¶165.

constant for all options.[23] In fact, the shapes of implied volatility curves (as a function of moneyness and as a function of time to maturity) are so distinct to have earned well known nicknames, such as volatility smile, smirk, frown, or skew.[24] Professor Heston does not mention these characteristics of implied volatilities. **Figure 2** below shows these implied volatility curves in terms of moneyness or time to expiry and contrasts them to the horizontal straight line that Professor Heston's methodology implies. It is clear that Professor Heston's methodology does not account for the variety of implied volatility curves that can exist in option prices.[25]

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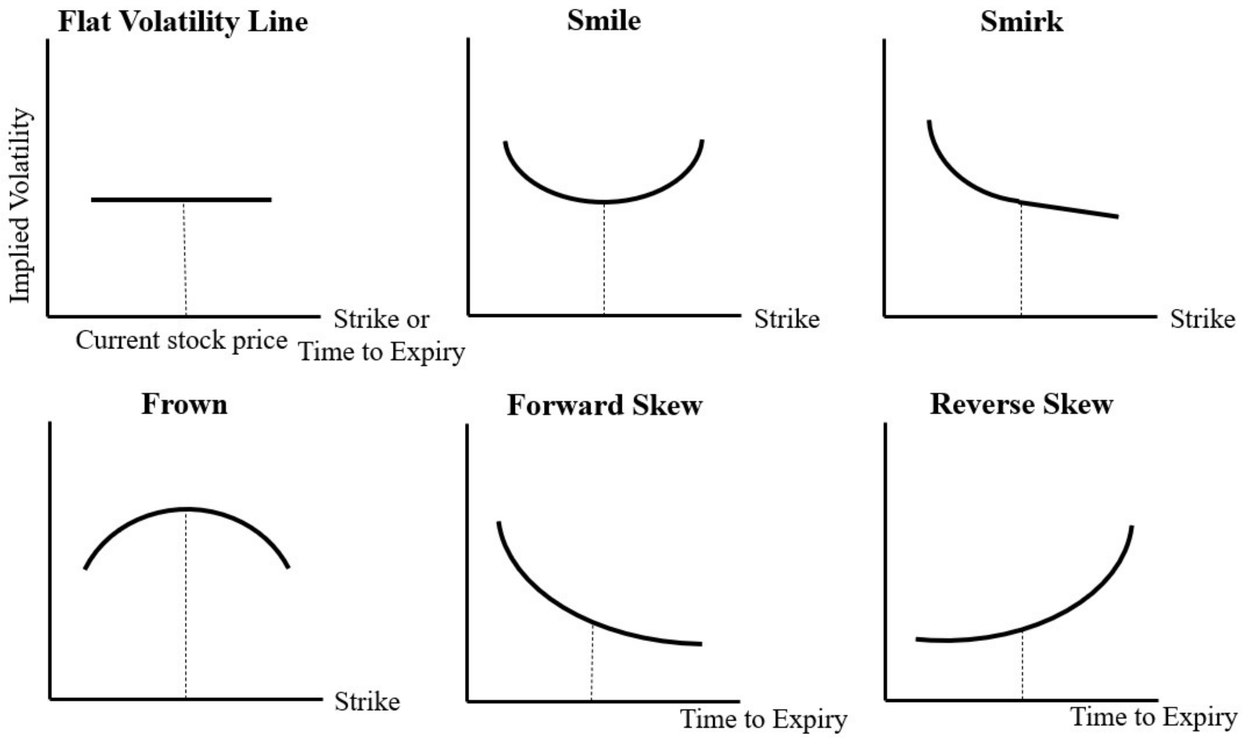
23 Mayhew (1995) states that the "consensus opinion is that the model performs reasonably well for at-the-money options with one or two months to expiration, and this experience has motivated the choice of such options for calculating implied volatility. For other options, however, the discrepancies between market and Black-Scholes prices are large and systematic" and that it is "well known that the implied volatilities of options differ systematically across strike prices and across time to expiration. The pattern of implied volatilities across times to expiration is known as the 'term structure of implied volatilities,' and the pattern across strike prices is known as the 'volatility skew' or the 'volatility smile,' a term that is sometimes used generally to refer to the pattern across both time to expiration and strike." Mayhew, Stewart (1995): "Implied Volatility," *Financial Analysts Journal* 51(4), 8-20.

24 Zhang and Xiang (2008) state "Rubinstein (1985) documented the phenomenon of the implied volatility smile before 1987, *i.e.*, the implied volatility of US equity index options, as a function of the strike price for a certain maturity, followed the pattern of a symmetric and smiling curve. Since the market crash in 1987, the implied volatility as a function of the strike price has been skewed towards the left… This phenomenon has been called the implied volatility smirk." Zhang, Jin E. and Yi Xiang (2008): "The implied volatility smirk," *Quantitative Finance* 8(3), 263–284. *Also see* Rubinstein, Mark (1985): "Nonparametric tests of alternative option pricing models using all reported trades and quotes on the 30 most active CBOE option classes from August 23, 1976 through August 31, 1978," *Journal of Finance* 40, 455–480.

25 Moreover, a merger event can change the shape of the implied volatility curve. As Bester et al. (2021) note on p.7, "…one would expect certain extreme events in the life of a firm to also affect the volatility smile. A natural candidate for an extreme event is the firm being the target of a merger attempt."

Figure 2: Implied volatility curves in terms of moneyness or time to expiry compared to the horizontal straight line that Professor Heston's methodology implies



23. **Exhibit 1** shows actual implied volatility curves for Tesla stock options on August 6. It is evident that Tesla's options exhibited an implied volatility curve between a smile and a smirk. They were not horizontal straight lines that Professor Heston's methodology implies. The same is true on August 8, after Mr. Musk's tweet and during the class period. See **Exhibit 2**. It is important to note that much of the trading volume in Tesla options during the class period involved options far out of the money.[26]

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[26] For example, on August 8, $50 puts were the most traded options expiring in January 2020 in terms of number of contracts, and $500, $600, and $700 calls exhibited high volumes as well.

24. As a consequence of these flaws, Dr. Hartzmark's implementation of Professor Heston's methodology is speculative, unreliable, and inaccurate and would allocate damages to option holders that were not damaged.[27]

25. For example, consider an investor who on August 7 sold a call option at market closing (purchased before the class period) with a January 2020 expiration and strike price of $500 (which was out of the money at that time). According to Dr. Hartzmark, that option was deflated by $2.18 on August 7, and the investor was damaged by selling the options at an artificially depressed price.[28] If Dr. Hartzmark had instead used the implied volatilities of the particular option being analyzed (keeping everything else in his damage calculation the same), he would have concluded that the option was inflated at the time of sale by $2.85, rather than deflated. Therefore, in this situation, Professor Heston's methodology allocates damages to an investor that was not damaged at all according to an alternative methodology that does not assume constant implied volatility across different strike prices.

26. As another example, consider an investor who on August 8 sold a put option (purchased before the class period) with a January 2020 expiration and strike price of $300 (which was out of the money at that time). According to Dr. Hartzmark, that option was deflated by $31.97 on August 8.[29] If Dr. Hartzmark had instead used the implied volatilities of the particular option being analyzed (keeping everything else in his damage calculation the same), he

[27] Because Professor Heston's methodology for estimating damages to Tesla option holders is fundamentally flawed and unreliable, it can also underestimate damages and allocate no damages to option holders that were damaged, assuming the plaintiff's allegations are correct.

[28] Hartzmark Report, Appendix 8, p. 17.

[29] Hartzmark Report, Appendix 8, p. 16.

would have concluded that the deflation at the time of sale was $26.34, 18 percent lower than his estimate. Therefore, in this situation, Professor Heston's methodology causes an overestimation of damages,[30] relative to an alternative methodology that does not assume constant implied volatility across different strike prices. This example shows that it is possible for Dr. Hartzmark to determine that an investor is on net damaged across all of that investor's trading in Tesla stock and options, while that investor would not be damaged according to an alternative methodology that does not assume constant implied volatility across different strike prices.

D. Professor Heston's methodology fails to use actual prices in the actual world to measure damages and fails to reliably estimate the difference between actual and but-for prices

27. Professor Heston's methodology does not use actual option prices to calculate damages. Instead, he uses a "re-valued" price based on the Black-Scholes model in place of the actual price. He claims that his use of a re-valued price rather than an actual price allows him to sidestep two issues: it allows him "to account for differences in outcomes investors experienced in the real world" and "to difference out potential model fitting biases in the levels."[31] Neither of these justifications is reasonable.

28. Professor Heston's first justification amounts to a claim that his re-valuation is a better estimate of the price investors paid for options than the actual prices paid or actual quotes. While it is true that actual prices paid and actual quotes can be on either side of the bid-ask spread, it is easy to calculate a mid-price from actual data. By instead using a model-based price, Professor Heston's methodology introduces errors in his estimate of actual prices.

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30 The put holder would be damaged by $31.97 according to Dr. Hartzmark, while the damage would be lower at $26.34 according to the alternative calculation.

31 Heston Report, ¶164.

29. In **Exhibit 3** I calculate the difference between model-based Tesla option prices using Professor Heston's straddle-based implied volatility and actual option prices.[32] As seen on the chart, the Black-Scholes model does not price even at-the-money options accurately (because the put-call parity does not hold, as explained above). In addition, the further out of the money options are, *i.e.*, the more the price of the options is based on optionality rather than on intrinsic value, the more the Black-Scholes model prices are inaccurate. The inaccuracy approaches 100 percent, meaning that Black-Scholes model prices are nearly double the actual prices (for out of the money calls) or nearly zero (for out of the money puts). This is true whether on August 6, before Mr. Musk's tweet, or on August 8, during the class period. See **Exhibit 4**.

30. Professor Heston's second justification amounts to a claim that while the Black-Scholes model is biased in levels (*i.e.*, it does not price options correctly), it is not biased in differences between levels (*i.e.*, it can accurately reflect the price change of an option if the expectations of future stock prices change). This is not just unsubstantiated and speculative, but also incorrect as a matter of fact. There is no reason to think that a model which is biased in levels would accurately capture price differences, and Professor Heston provides no evidence that the Black-Scholes model is accurate in changes or differences. As I explained above, the Black-Scholes model is not appropriate when a company is involved in a merger or acquisition deal because of the underlying assumptions about the nature of the expectations of future stock prices.[33] The Black-Scholes model cannot accurately price options, that is, it is biased both in

[32] To calculate the Black-Scholes model prices, I use the same parameters that Dr. Hartzmark uses in his calculations of "Re-Valued Fitted Option Value" in Appendix 8 and as described in footnote 322 of the Hartzmark Report. Implied volatility is calculated from the forward at-the-money straddle with the same expiration date as the option being analyzed. I use actual option mid-prices.

[33] *See* Section III.A.

levels and in differences, when there is a change in expectations of stock returns from a bell-shaped distribution to one with a peak at the expected deal price.

31. To see that the pricing errors resulting from Heston's use of the Black-Scholes model do not cancel out when differencing two model-based prices, consider differences between two actual option prices and compare that difference to the difference between two model-based option prices. I perform such an analysis using differences between August 6 and August 8 prices of put and call options expiring in January 2020. As mentioned above, these are the options that both Professor Heston and Dr. Hartzmark use in their analysis.[34] If Professor Heston's view is correct that the Black-Scholes model is not biased in differences between levels, the hollow and solid circles in **Exhibit 5A** representing actual and model-based call price differences, respectively, should overlap. They do not. The same is true for put option prices – see **Exhibit 5B**.[35]

32. Dr. Hartzmark applies Professor Heston's methodology including the use of a "re-valued" price based on the Black-Scholes model in place of the actual price both to (1) estimate damages on Tesla options, as well as to (2) dividing total inflation into "direct" and "consequential" components (which I analyze in Section IV below).[36] As a consequence of these flaws, Dr. Hartzmark's implementation of Professor Heston's methodology is speculative,

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[34] *See, e.g.*, Hartzmark Report, p. 132; Heston Report, pp. 49-55.

[35] The solid circles represent the price change that Professor Heston would estimate when refitting prices using Black-Scholes model and the implied volatility of the at-the-money straddle on those dates. To calculate the Black-Scholes model prices, I use the same parameters that Dr. Hartzmark uses in his calculations of "Re-Valued Fitted Option Value" in Appendix 8 and as described in footnote 322 of the Hartzmark Report. Implied volatility is calculated from the forward at-the-money straddle with the same expiration date as the option being analyzed.

[36] Hartzmark Report, ¶221.

unreliable, and inaccurate and would allocate damages to option holders that were not damaged. In the next section, I explain that Dr. Hartzmark's methodology for dividing inflation is also arbitrary and fundamentally flawed.

IV. DR. HARTZMARK'S USE OF THE JANUARY 2020 AT-THE-MONEY FORWARD STRADDLE TO ESTIMATE HOW THE PROBABILITY OF DEAL COMPLETION AND THE "DIRECT" EFFECT OF MR. MUSK'S TWEET CHANGED OVER THE CLASS PERIOD IS ARBITRARY AND FUNDAMENTALLY FLAWED

33. Dr. Hartzmark first calculates the inflation over the class period then divides it into "direct" and "consequential" components. According to Dr. Hartzmark, "direct" inflation was caused by "information allegedly misrepresented and/or omitted in the Musk Tweets" while "consequential" inflation was caused by "disclosures following the Musk Tweets exposing their falsity."[37]

34. To make this division, he uses the price movements of the January 2020 at-the-money straddle.[38] In particular, Dr. Hartzmark first estimates that "direct" inflation at market closing on August 7 was $23.27, while it was zero at market closing on August 17, the end of the class period.[39] At the same time, implied volatility of the January 2020 at-the-money straddle was 33% on August 7 and increased to 49% on August 17 (that is, the price of the straddle increased over that period, which, according to the Black-Scholes model, implies an increase in

[37] Hartzmark Report, ¶4a. As examples of "consequential" effects, he lists "Tesla's reduced management credibility and revealed failures of corporate governance and internal controls, as well as Tesla's increased legal risks and scrutiny from U.S. Securities and Exchange Commission ('SEC') investigations."

[38] Hartzmark Report, ¶193.

[39] Hartzmark Report, ¶181.

implied volatility).[40] He then translates this increase in implied volatility of 16 percentage points, from 33 to 49 percent, into proportional decreases in "direct" inflation. For example, on August 8, implied volatility had increased by 5% to 37%, which is 28% of the total increase in implied volatility of 16%.[41] As a result, Dr. Hartzmark assumes that on August 8, 28% of the initial inflation as a "direct" effect of Mr. Musk's tweet has dissipated, resulting in an inflation estimate of $16.75 on August 8.[42]

35. Dr. Hartzmark's analysis attributing all movements in implied volatility of a particular portfolio of options to changes in inflation resulting directly from Mr. Musk's tweet is fundamentally flawed. Furthermore, his selection of the January 2020 at-the-money forward straddle in estimating the implied volatility throughout this period is arbitrary.

A. Dr. Hartzmark's assumption that all movements in implied volatility throughout the class period are due to changes in the "direct" effect of Mr. Musk's tweet is fundamentally flawed

36. Dr. Hartzmark does not explain why the "consequential" effects, as he defines them, could not themselves increase implied volatility. According to Dr. Hartzmark, "consequential" effects increase the risk of future Tesla performance in terms of management credibility, corporate governance, internal controls, and litigation.[43] It is plausible that an increase in these risks also increases the variability of future stock returns, which in the Black-Scholes model increases implied volatility. But Dr. Hartzmark applies the entire increase of

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40 Hartzmark Report, ¶197.

41 28.05% = (37.08% – 32.57%) / (48.65% – 32.57%) ~= 5% / 16%

42 $16.75 = (1 – 28.05%) * $23.27

43 Hartzmark Report, ¶4a.

implied volatility during the class period to "direct" effect of Mr. Musk's tweet, and attributes none of the increase of implied volatility to "consequential" effects.

37. In addition, Dr. Hartzmark makes no effort to examine whether the changes in implied volatility during the class period are affected by market factors, industry events, or other Tesla-related news.

38. In short, Dr. Hartzmark's assumption that all movements in implied volatility throughout the class period are due to changes in the "direct" effect of Mr. Musk's tweet is fundamentally flawed.

B. Dr. Hartzmark's choice to analyze the implied volatility of the January 2020 at-the-money forward straddle is arbitrary, and his results are not robust against reasonable alternatives

39. First, Dr. Hartzmark's choice to analyze the particular straddle with the January 2020 expiration date is arbitrary. In **Exhibit 6** I reconstruct what Dr. Hartzmark's results would have been had he chosen alternative expiration dates. As the exhibit shows, Dr. Hartzmark "direct artificial inflation" would have differed by as much as 13 percent had he used the second or third longest straddles by time to expiration.

40. Second, Dr. Hartzmark's choice to analyze a straddle is arbitrary. Had Dr. Hartzmark's chosen to analyze the at-the-money call option and put option expiring in January 2020 separately, his results would also have been different. As I show in **Exhibit 1** and **Exhibit 2**, put-call parity did not hold for Tesla put and call options with expirations in January 2020 based on the Black-Scholes model. The differences in implied volatility for different types of options, as shown in these exhibits, impact Dr. Hartzmark's "direct artificial inflation."

41. Finally, Dr. Hartzmark's choice to analyze at-the-money options is arbitrary. Had Dr. Hartzmark's chosen to analyze options expiring in January 2020 of different degrees of moneyness, his results would also have been different. As I show in **Exhibit 1** and **Exhibit 2**, Tesla options exhibited an implied volatility curve between a smile and a smirk. They were not horizontal straight lines that Professor Heston's methodology implies, which impact Dr. Hartzmark's estimate of "direct artificial inflation."

December 8, 2021

Amit Seru

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AMIT SERU

Stanford University
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ACADEMIC POSITIONS

2016- ***Stanford University, Graduate School of Business, Stanford CA***
Steven and Roberta Denning Professor of Finance 2017-
R. Michael and Mary Shanahan Faculty Fellow 2018-19, 19-20
Professor of Finance, 2016-2017
Senior Fellow, Hoover Institution
Senior Fellow, Stanford Institute for Economic Policy Research (SIEPR)

2007-2016 ***University of Chicago, Booth School of Business, Chicago IL***
Dennis and Karen Chookaszian Professor of Finance, 2015-2016
David Booth Faculty Fellow, 2015-2016
Co-Director of Fama Miller Center, 2015-2016
Professor of Finance, 2013-2014
Associate Professor of Finance, 2011-2012
Assistant Professor of Finance, 2007-2010

2011- ***National Bureau of Economic Research***
Research Fellow, Corporate Finance and Monetary Economics Programs

2017- ***Center for Economic Policy Research***
Research Fellow, Financial Economics Program

2013-2014 ***Alfred P. Sloan Foundation and the Russell Sage Foundation***
Working Group on Behavioral Economics/Consumer Finance

EDUCATION

2007 Ph. D in Finance, **University of Michigan**
1998 M.B.A, **University of Delhi**
1996 B. E (Electronics & Communication), **University of Delhi**

ACADEMIC HONORS AND AWARDS

2020: Finalist, MBA Distinguished Teaching Award
2019: Monetary Authority of Singapore Term Professor in Economics and Finance
Biennial Andrew Crockett Memorial Lecture, Bank for International Settlements
Keynote on Shadow Banking at Financial Stability Institute
Keynote on Shadow Banking at Midwest Finance Association
Keynote on Shadow Banking at Indian School of Business
Journal of Financial Economics Paper Prize in Corporate Finance (Second Prize)
R. Michael and Mary Shanahan Faculty Fellow
2018: Alexandre Lamfalussy Senior Research Fellow, Bank for International Settlement
MBA Distinguished Teaching Award (School wide)
R. Michael and Mary Shanahan Faculty Fellow
2016: National Science Foundation Award (1628895)
Rising Star in Finance Award

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	Hillel J Einhorn Excellence in Teaching x 2
2015:	Journal of Financial Economics Paper Prize in Corporate Finance (First Prize)
	Emory Williams Annual (School wide) Teaching Award
2014:	IMF Generation Next: 25 economists under 45 shaping the way we think about future
	AER Excellence in Refereeing
	QJE Excellence in Refereeing
	AQR Insight Award (Second Prize)
	Crowell Memorial Prize, Panagora Asset Management
	Finalist, MacArthur Foundation Grant
2012:	Best paper, Red Rock Conference
2011:	Chookaszian Endowed Risk Management prize
2008:	Best paper awards at European Finance Association, CAF Research Conference, NSIM Conference and Mistsui Research Conference
	BSI research award
2001-06:	Rackham Pre-doctoral Fellowship and Dykstra Fellowship
1992-98:	Sanwa Bank Scholarship for academic excellence (MBA)
	Lt. Governor's gold medal for academic excellence (BE)
	Chief Minister's gold medal for overall excellence (BE)

RESEARCH INTERESTS

Financial Intermediation and Regulation, Resource Allocation and Internal Organization of Firms, Performance Evaluation and Incentives

PUBLICATIONS

When Harry Fired Sally: The Double Standard in Punishing Misconduct (with Egan and Matvos), 2021. [Forthcoming, **Journal of Political Economy**]

Government and Private Household Debt Relief during Covid-19 (with Cherry, Jiang, Matvos and Piskorski), 2021. [Forthcoming, **Brookings Papers on Economic Activity**, Fall 2021]

Financing Labor (with Benmelech and Bergman), 2021 [Forthcoming, **Review of Finance**]

*Mortgage Refinancing, Consumer Spending, and Competition: Evidence from the Home Affordable Refinancing Program (*with Agarwal, Amromin, Chomsisengphet, Landvoigt, Piskorski and V Yao), 2020 [Forthcoming, **Review of Economic Studies**]

Measuring Technological Innovation over the Long Run (with Kelly, Papanikolaou and Taddy), 2020 [Forthcoming, **American Economic Review: Insights**]

Debt Relief and Slow Recovery: A Decade after Lehman (with Piskorski), 2020 [Forthcoming, **Journal of Financial Economics**]

Disguised Corruption: Evidence from Consumer Credit in China, 2019 *(*with Agarwal, Qian and Zhang), **Journal of Financial Economics**, Forthcoming

Fintech, Regulatory Arbitrage and the Rise of Shadow Banks (with Buchak, Matvos and Piskorski), **Journal of Financial Economics**, 2018

The Market for Financial Adviser Misconduct (with Egan and Matvos), **Journal of Political Economy,** 2018.

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*Mortgage Market Design: Lessons from the Great Recession (*with Piskorksi), **Brookings Papers on Economic Activity**, Spring 2018

*Financial Market Frictions and Diversification (*with Matvos and Silva), **Journal of Financial Economics**, 2018

"Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging" (with Di Maggio, Kermani, Keys, Piskorski, Ramcharan, and Yao), **American Economic Review**, 2017
[Note: this is a combined version of working papers Monetary Policy Pass-Through: Household Consumption and Voluntary Deleveraging by M. Di Maggio, A. Kermani and R. Ramcharan previously Revise & Resubmit at *American Economic Review* and Mortgage Rates, Household Balance Sheets, and the Real Economy by B. Keys, T. Piskorski, A. Seru, and V. Yao previously Revise and Resubmit at *Journal of Political Economy]*

*Policy Intervention in Debt Renegotiation: Evidence from Home Mortgage Affordability Program (*with Agarwal, Amromin, Ben-David, Chomsisengphet and Piskorski*),* **Journal of Political Economy**, 2017

Regional Redistribution through the US Mortgage Market (with Hurst, Keys and Vavra) **American Economic Review**, 2016.

Technological Innovation, Resource Allocation and Growth (with Kogan, Papanikolaou and Stoffman), **Quarterly Journal of Economy**, 2016.

Advertising Expensive Mortgages (with Gurun and Matvos), **Journal of Finance**, 2016

Selling Failed Banks (with Granja and Matvos), **Journal of Finance**, 2016

Asset Quality Misrepresentation by Financial Intermediaries (with Piskorski and Witkin), **Journal of Finance,** 2015.

The Failure of Models that Predict Failure (with Uday Rajan and Vikrant Vig), **Journal of Financial Economics,** 2015.

Inconsistent Regulators: Evidence from Banking (with Agarwal, Lucca and Trebbi), **Quarterly Journal of Economics**, 129(2), 2014.

The Revolving Door and Worker Flows in Banking Regulation, (with Lucca and Trebbi), **Journal of Monetary Economics**, 65, 2014.

Firm Boundaries Matter: Evidence from Conglomerates and R&D Activity (earlier titled "Do Conglomerates Stifle Innovation?"), **Journal of Financial Economics,** 2014.

Internal Capital Markets and Dividend Policy: Evidence from Business Groups (with Radha Gopalan and Vikram Nanda), **Review of Financial Studies,** 2014.

Resource Allocation within Firms and Financial Market Dislocation (with Matvos), **Review of Financial Studies,** 2014.

*Lender Screening and Role of Securitization: Evidence from Prime and Subprime Mortgages (*with Ben Keys and Vikrant Vig*),* **Review of Financial Studies,** 2012.

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Are Incentive Contracts Rigged by Powerful CEOs? (with Adair Morse and Vikram Nanda), **Journal of Finance**, 2011.

Learning by Trading (with Tyler Shumway and Noah Stoffman), **Review of Financial Studies,** 23(2), 2010.

Securitization and Distressed Loan Renegotiation: Evidence from the Subprime Crisis (with Tomasz Piskorski and Vikrant Vig), **Journal of Financial Economics**, 97, 2010.

Statistical Default Models and Incentives (with Uday Rajan and Vikrant Vig), **American Economic Review, Papers and Proceedings**, 2010.

*Did Securitization Lead to Lax Screening: Evidence from Subprime Loans (*with Benjamin Keys, Tanmoy Mukherjee and Vikrant Vig), **Quarterly Journal of Economics**, 125(1), 2010.

*Financial Regulation and Securitization: Evidence from Subprime Loans (*with Benjamin Keys, Tanmoy Mukherjee and Vikrant Vig)*,* **Journal of Monetary Economics,** 56(5), 2009.

Fund Manager Use of Public Information: New Evidence on Managerial Skills (with Marcin Kacperczyk), **Journal of Finance**, 62, 2007. Lead Article. Nominated for Smith Breeden Award.

Affiliated Firms and Financial Support: Evidence from Indian Business Groups (with Radha Gopalan and Vikram Nanda), **Journal of Financial Economics**, 86, 2007.

WORKING PAPERS

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*Why is Intermediating Houses so Difficult? Evidence from iBuyers (*with Buchak, Matvos and Piskorski), 2021

*Beyond the Balance Sheet Model of Banking: Implications for Bank Regulation and Monetary Policy (*with Buchak, Matvos and Piskorski), 2021 [Revise and Resubmit, **Journal of Political Economy**]

Searching for Approval (with Agarwal, Matvos, Grigsby, Hortacsu and Yao), 2021 [Revise and Resubmit, **Econometrica**]

Banking without Deposits: Evidence from Shadow Bank Call Reports (with Jiang, Matvos and Piskorski), 2020

*Abritration with Uniformed Consumers (*with Egan and Matvos), 2021 [Revise and Resubmit, **Review of Economic Studies**]

From Rotten Apples to Rotten Orchards: Labor Market Sorting and Wrongdoing in the Financial Advisor Industry (with Vicinanza, Egan, Rao and Matvos), Working Paper 2020

Did Community Investment Act lead to Riskier Lending? (with Agarwal, Benmelech and Bergman) [Revise and Resubmit, **Journal of Political Economy**]

Information, Credit and Organization (with Liberti and Vig), 2017 [Revise and Resubmit, **Journal of Financial Economics**]

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CONFERENCE PRESENTATIONS

2021:	Brookings, NBER Household, NBER Real Estate, NABE/NBER
2020:	NBER Capital Markets, SITE
2019:	SIEPR India Conference, Berkeley-Stanford, NBER Household, NBER Corporate, NBER Monetary, BIS Annual Conference, SITE
2018:	Brookings, SIEPR India Conference, Berkeley-Stanford, Stanford Innovation Summit, NBER Neemrana, Wharton Liquidity Conference, RCFS Bahamas Conference, Texas Austin Symposium on Crisis, SITE
2017:	SAFE/Goethe Conference, ECB, SITE, Berkeley-Stanford
2016:	Rising Star Conference, GSE Barcelona, Mitsui Michigan, ABEFR conference, Imperial/FCA Conference
2015:	SITE, NBER Monetary, NBER Real Estate, NUS Housing conference, European Symposium in Financial Markets (Gerzensee)
2014:	NUS Housing Conference, Symposium on Economics and Institutions, ISB Summer Symposium, FRIC Conference, NBER Household Finance, USC Organizations Conference
2013:	AEA, AFA, AQR Inquire Award, Focus group at European Symposium in Financial Markets (Gerzensee), Red Rock Conference
2012:	AEA, JAR-NY Fed, Conference on State Banking Supervisors, Kellogg Finance Conference, NBER Summer Corporate, NBER Monetary, NBER Real Estate, WFA, Red Rock Conference, Focus group at European Symposium in Financial Markets (Gerzensee)
2011:	AEA, NBER Housing, NBER Corporate
2010:	AFA, AEA, Econometric Society, Conference on Housing Market Dynamics, NBER Pre-Conference on Housing and Financial Crisis, NBER Conference on Housing and Financial Crisis, 58th Annual Management Conference Chicago Booth
2009:	AFA, Mitsui Symposium at Michigan, NBER Corporate (Spring & Summer), NBER Monetary Economics (Summer), NBER Real Estate (Summer), NBER Law and Economics (Summer), NBER Securitization Meeting, NBER Household Finance, KU Southwind Conference, FMRC Conference on the Role of Government Regulation
2008:	AFA, Focus group at European Symposium in Financial Markets (Gerzensee), EFA, Mitsui Symposium at Michigan, Moody's/NYU Credit Risk Conference, NBER Corporate (Spring), SITE Workshop (Insurance and Credit Markets)
2007:	AFA, Batten Young Scholar
2004-2006:	WFA, EFA, UNC Conference on FEA, Northern Finance Association Meetings, EFMA, Pacific Northwest Finance Conference

SEMINAR PRESENTATIONS

2021:	Chicago Booth*, Utah*, Stanford, NY Fed, Minneapolis Fed, Fed Board, Banco de Portugal, ECB, Banco Central de Uruguay, FDIC
2020:	Princeton, Georgetown, Stanford, BIS, Rice, Michigan, Texas Austin, Dartmouth, Carlson
2019:	MIT Sloan, HBS, BIS, Stanford, NUS, MAS,
2018:	Olin, Kellogg, NYU, Yale, BIS, Stanford, AQR
2017:	Stanford (Engineering, Math), BIS, HKMA

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2016:	Wharton, Dartmouth, Berkeley, UNC, NY Fed, LBS, LSE, Stanford
2015:	Stanford, Chicago Booth, NUS
2014:	NYU, HEC, Michigan, Rutgers, Stanford, OSU, UBC, MIT Sloan
2013:	Chicago Booth, Purdue, Rice, Stockholm School of Economics, DePaul, Bocconi
2012:	Chicago Booth, Insead, Columbia GSB, USC, Kellogg, Arizona, USC, Darden, Oregon, HBS, UCLA, Berkeley, Arizona State, Princeton
2011:	Chicago Fed, Chicago Booth (x3), DePaul University, Stockholm School of Financial Research, Texas Austin, OCC
2010:	Chicago Booth, Wharton, Loyola, Berkeley, Michigan, NYU, AQR
2009:	Amsterdam School of Business, BYU, Berkeley, Chicago Booth, Columbia GSB, DePaul, Harvard Economics/HBS, MIT Sloan, NY Fed, Stanford, UCLA, UIC
2008:	Boston College, Chicago Booth (x2), Chicago Fed, IMF, Kellogg, Michigan, Michigan State, Olin WashU, Princeton, Standard and Poor's
2007:	Arizona State, Boston College, Chicago Booth, Colorado, Duke, HBS, London Business School, NYU, Ohio, Rochester, Toronto, UBC, Wharton, Yale

PROFESSIONAL ACTIVITIES

Journals:	**Journal of Finance** (Co-editor, 2016-; Associate Editor (AE), 2014-2016) **Journal of Political Economy** (AE, 2016-2018) **Management Science** (Department Editor, 2014-2016; AE, 2012-2013) **Review of Corporate Financial Studies** (Editor, *2014*-2016) **Journal of Financial Intermediation** (AE, 2013-2016)
Journal Referee:	American Economic Review, AEJ: Applied Microeconomics, AEJ: Microeconomics, AEJ: Macroeconomics, Econometrica, Journal of Finance, Journal of Financial Economics, Journal of Financial Intermediation, Journal of Economic Growth, Journal of Political Economy, Quarterly Journal of Economics, Journal of Financial and Quantitative Analysis, Review of Economic Studies, Review of Economics and Statistics, Review of Financial Studies, Journal of Law and Economics
Keynote/Lecture:	ECB Lectures 2021; Markus Academy 2020/Princeton Lectures in Finance; BIS Annual Meetings 2019; BIS/CEPR Conference, 2019; MFA, 2019; ISB Summer Conference 2019; FDIC Annual Conference, 2019.
Panels:	Journal Editors Panel, UT Austin 2021; RFS/NBER Conference on Inequality, Discrimination and the Financial System 2021; Covid-19 Bailout Debate, Stanford GSB 2020; AFA Innovating for Financial Health 2020; Technology Innovation and Future of the US Economy, Hoover Centennial Series 2019.
Discussant:	Stanford Accounting Bootcamp (2020), NBER Corporate Finance (2019), Nobel Symposium on Money and Banking (2018), NBER Global Crisis @10 (2018), Bundesbank (2017), AFA (2013, 2012, 2009, 2008), WFA (2012, 2011; 2010; 2007), AEA (2013, 2012), Bank Structure Conference (2011), FDIC Conference (2010), Moody's/NYU Credit Risk Conference (2010), IMF Twelfth Jacques Polak Annual Research Conference (2011), NBER Behavioral Asset Pricing (2012), NBER Corporate Finance (2009,

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	2013, 2015, 2017, 2018, 2019), NBER Entrepreneurship (2009), NBER Real Estate (2012), NBER Market Institutions and Financial Market Risk (2010), NBER Monetary Economics (2014, 2012, 2009), RFS Entrepreneurship Conference (2010), Summer Symposium (2014, 2012, 2010, 2009), RCFS Conference (2011)
Program Committee:	AFA (2019, 2017, 2016, 2014, 2012, 2010), EFA (2006-2013), FMA (2009), FMA Award Committee (2009), Olin Corporate Finance Conference (2008-2011), WFA (2010-2012, 2014-2020), Mid-Atlantic Research Conference (2011).
Chair	AEA (2012), WFA (2011), AFA (2021, 2019, 2018, 2011, 2010)
Others:	Co-Organized SITE on Financial Regulation (2017 - 2021). Organizer of Corporate Finance week at European Symposium in Financial Markets (2016 and 2017). Corporate Finance Reading Group at Booth (2013-2016) Co-organized NBER Summer Institute, Corporate Finance Program (2016) Co-organized or conference on Financial Regulation at Becker Friedman Institute (2015) Organized Finance, Organization and Markets conference (2015) Organizer of Focus group on *Information and Organization* at European Symposium in Financial Markets (2013). Moderator at Chicago Bank Structure Conference (2011, 2013) Moderator at FDIC Conference (2010) Co-organizer of conference on Regulating Financing Intermediaries (2011). Panelist at Mortgage Bankers Association Conference (2011)

PhD STUDENTS SUPERVISED/COMMITTEES

2020	Becky Zhang (Amazon)
2019	Sam Antill (HBS), Yang Zhao (Amazon), Erica Jiang (USC)
2018	Greg Buchak (Stanford GSB), Jose Barrero (ITAM), Ryan Shu (Amazon)
2017	Adam Jorring (Boston College), Emanuele Colonneli (Chicago Booth), Yiming Ma (Columbia GSB)
2016	Aaron Pancost (Texas Austin), Ben Charoenwong (NUS)
2015	John Nash (HKUST), Chenfei Lu (Uber)
2014	Nitish Kumar (Florida), Mark Egan (Minnesota), Rasool Zandvakil (IMF), Wei Wu (Texas), Adrien Matray [external reviewer] (Princeton)
2013	Filipe Lacerda (Cornerstone), Roie Hauser (Temple)
2012	Marina Niessner (Yale); Ram Chivukula (JP Morgan)
2011	Matthew Plosser (New York Fed); Rui Silva (London Business School)
2010	Roni Kisin (Olin School of Business), Jennifer Bontas (Analysis Group)

BOOK CHAPTERS

2015	*Gene Fama's contribution to Corporate Finance (with Amir Sufi),* The Fama Portfolio (editors John Cochrane and Tobias Moskowitz)
2012	*Mortgage Financing during Boom and Bust (with Ben Keys, Tomasz Piskorski and Vikrant Vig),* NBER Chapter in Volume on Housing and Financial Crisis (editors Ed Glaeser and Todd Sinai)
2010	*Lessons from the financial crisis: causes, consequences, and our economic future*

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2009 *Economics 2.0: What the best minds in economics can teach you about business and life*

MEDIA MENTIONS

American Banker, Bloomberg, Business Week, Chicago Tribune, Condé Nast (Portfolio), Economist, Financial Times, Forbes, Housing Wire, Reuters, New York Times, National Public Radio, Wall Street Journal, Washington Post

TEACHING EXPERIENCE

Corporations, Finance and Governance in the Global Economy at Stanford GSB, Advanced Empirical Corporate Finance (PhD) at Stanford GSB, Corporate Finance (Accelerated) elective at Stanford GSB, Corporation Finance for Executives (35801) taught at University of Chicago, Valuing Control around the World (35816), elective class, Corporation Finance (35200) taught at University of Chicago; Empirical Corporate/Banking (PhD) taught at Chicago/Michigan/SSE; Corporate Financial Policy (FIN 314) taught at University of Michigan

OTHER WORK EXPERIENCE

1998-2001 *Accenture*, Senior Consultant

2017-2018 Expert Witness for Plaintiff, China Development Industrial Bank (CDIB) v. Morgan Stanley & Co., 2017. Deposition in 2018 (2 days). *Status: Settled.*

CDIB accused Morgan Stanley of having dumped losses from the CDO onto it in April 2007, after having earlier represented that the security was almost risk-free and more stable than a triple-A rated bond.

2019 Expert Witness for Plaintiff, People of the State of California v. Morgan Stanley & Co. *Status: Settled.*

Plaintiff accused Morgan Stanley for misrepresenting asset backed securities that Plaintiff invested in.

2020- Expert Witness for Plaintiff, People of the State of California v. Navient & Corp et al. *Status: Ongoing*

Plantiff accused Navient of misconduct in the servicing and collection of federal student loans.

2021- Expert Report for Nomura International Plc in the case of European Commission v. Nomura International Plc and Nomura Holdings Inc. *Status: Ongoing*

The commission alleged that eight banks (including Nomura) participated in a collusive scheme to distort competition and trading.

APPENDIX B

Materials Considered

Expert Reports

Expert Report of Steven L. Heston, November 8, 2021.

Expert Damages Report of Michael L. Hartzmark, November 10, 2021.

Academic Journal Articles

Barone-Adesi, Giovanni, Keith C. Brown, and W.V. Harlow (1994): "On the Use of Implied Volatilities in the Prediction of Successful Corporate Takeovers," *Advances in Futures and Options Research* 7, 147-165.

Bester, C. Alan, Victor H. Martinez, and Ioanid Rosu (2021): "Option Prices and the Probability of Success of Cash Mergers," *Journal of Financial Econometrics*.

Cremers, Martijn and David Weinbaum (2010): "Deviations from Put-Call Parity and Stock Return Predictability," *Journal of Financial and Quantitative Analysis* 45(2), 335-367.

Kamara, Avraham and Thomas W. Miller, Jr. (1995): "Daily and Intradaily Tests of European Put-Call Parity," *Journal of Financial and Quantitative Analysis* 30(4), 519-539.

Mayhew, Stewart (1995): "Implied Volatility," *Financial Analysts Journal* 51(4), 8-20.

Rubinstein, Mark (1985): "Nonparametric tests of alternative option pricing models using all reported trades and quotes on the 30 most active CBOE option classes from August 23, 1976 through August 31, 1978," *Journal of Finance* 40, 455–480.

Subramanian, Ajay (2004): "Option Pricing on Stocks in Mergers and Acquisitions," *Journal of Finance* 59(2), 795-829.

Zhang, Jin E. and Yi Xiang (2008): "The implied volatility smirk," *Quantitative Finance* 8(3), 263–284.

News Articles

"Elon Musk: The architect of tomorrow," Rolling Stone, November 15, 2017.

"Musk's conduct, Tesla stock slide make $700 million profit for short-sellers," Reuters, May 3, 2018.

"Tesla's Short Squeeze Unwinds as Borrowing Costs Fall," Wall Street Journal, September 28, 2016.

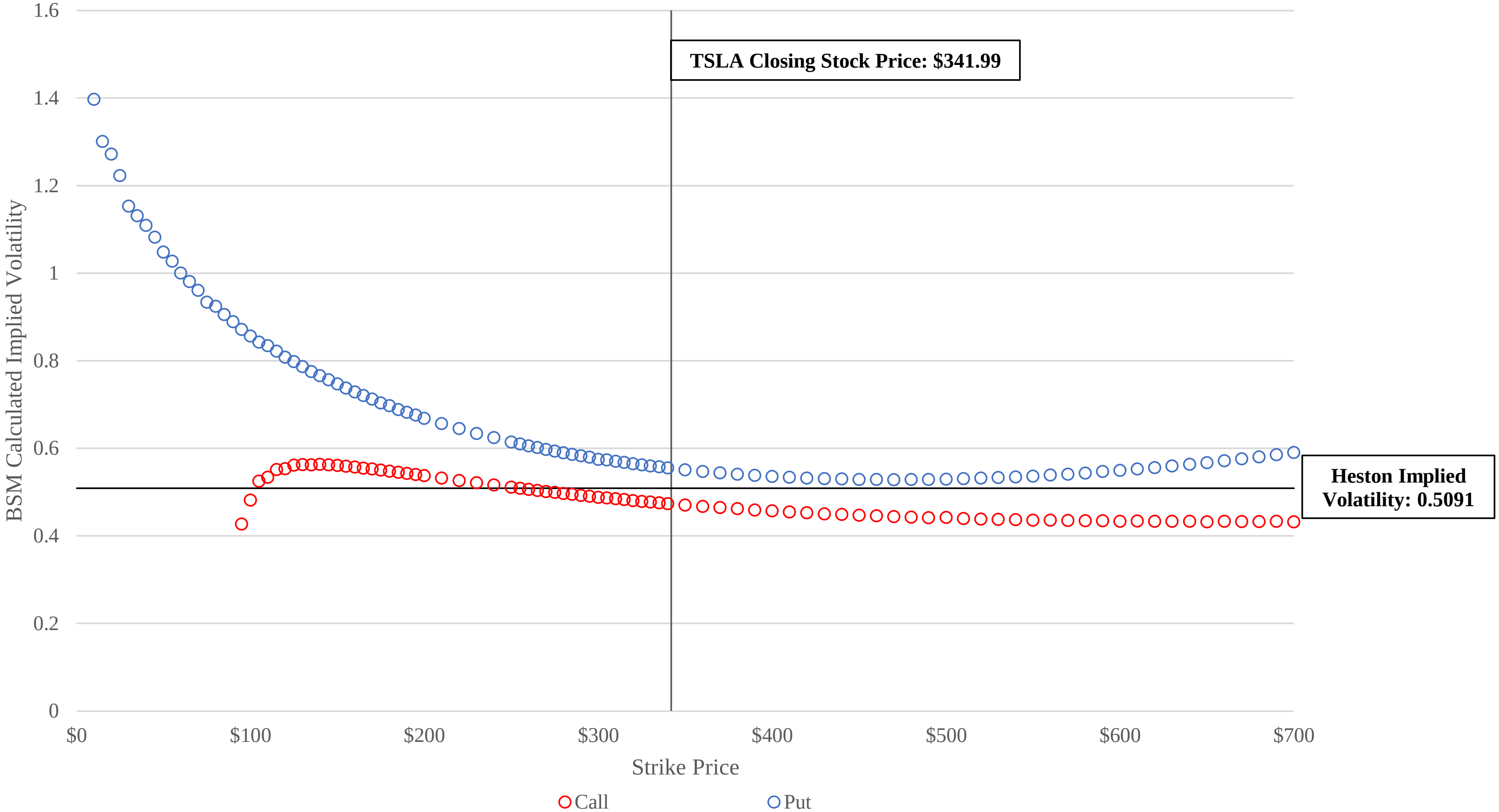
"Tesla is heavily shorted across the capital structure," IHS Markit, March 26, 2018.

Data

CBOE Data

Exhibit 1

Implied Volatility of TSLA Call and Put Options Compared to Heston Straddle on August 6, 2018 for Options Expiring January 17, 2020

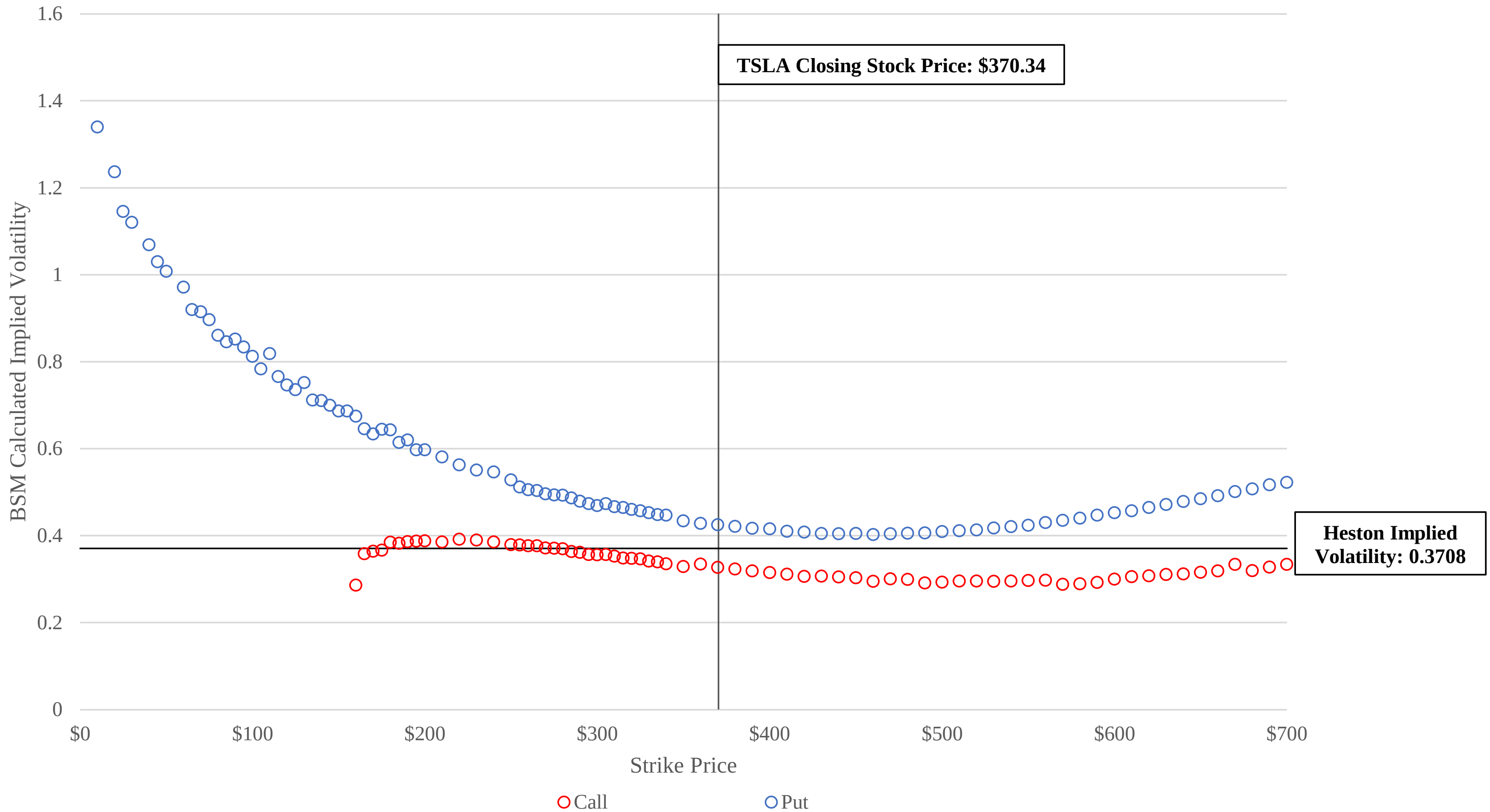


Notes:
1. The BSM Calculated Implied Volatility for the close of trading call and put options are computed based on the Black Scholes model, using mid prices calculated as the average of the bid and ask prices, and rely on Heston's provided CBOE DataShop Option Intervals data. Assumes a continuously compounded risk-free rate of 2.43%.
2. Excludes options for which the bid or ask price is zero and options with zero open interest.
3. Excludes call options with strike price below $95 as actual prices for these call options are lower than what the Black Scholes model allows.
4. The Heston Implied Volatility of 0.5091 is from the Heston Report, Table 6, which contains Heston's calculated implied volatility for the August 6, 2018 close of trading ATM-forward straddle prices with a January 17, 2020 option expiry date.

Sources: CBOE Data, Heston Report, Hartzmark Report.

Exhibit 2

Implied Volatility of TSLA Call and Put Options Compared to Heston Straddle on August 8, 2018 for Options Expiring January 17, 2020

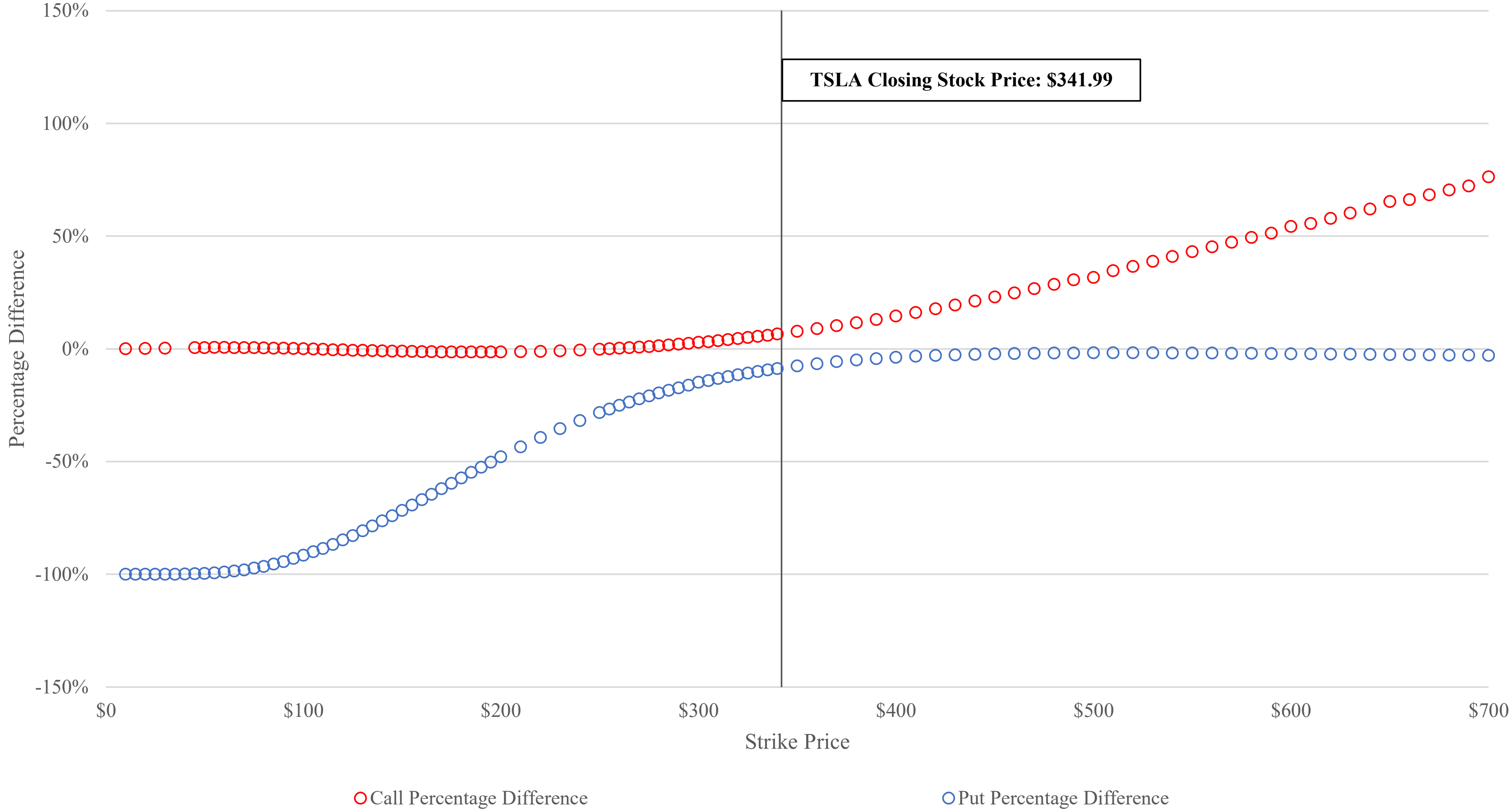


Notes:
1. The BSM Calculated Implied Volatility for the close of trading call and put options are computed based on the Black Scholes model, using mid prices calculated as the average of the bid and ask prices, and rely on Heston's provided CBOE DataShop Option Intervals data. Assumes a continuously compounded risk-free rate of 2.43%.
2. Excludes options for which the bid or ask price is zero and options with zero open interest.
3. Excludes call options with strike price below $160 as actual prices for these call options are lower than what the Black Scholes model allows.
4. The Heston Implied Volatility of 0.3708 is from the Heston Report, Table 6, which contains Heston's calculated implied volatility for the August 8, 2018 close of trading ATM-forward straddle prices with a January 17, 2020 option expiry date.

Sources: CBOE Data, Heston Report, Hartzmark Report.

Exhibit 3

Percentage Difference Between Model-Based and Actual TSLA Option Prices on August 6, 2018 for Options Expiring January 17, 2020

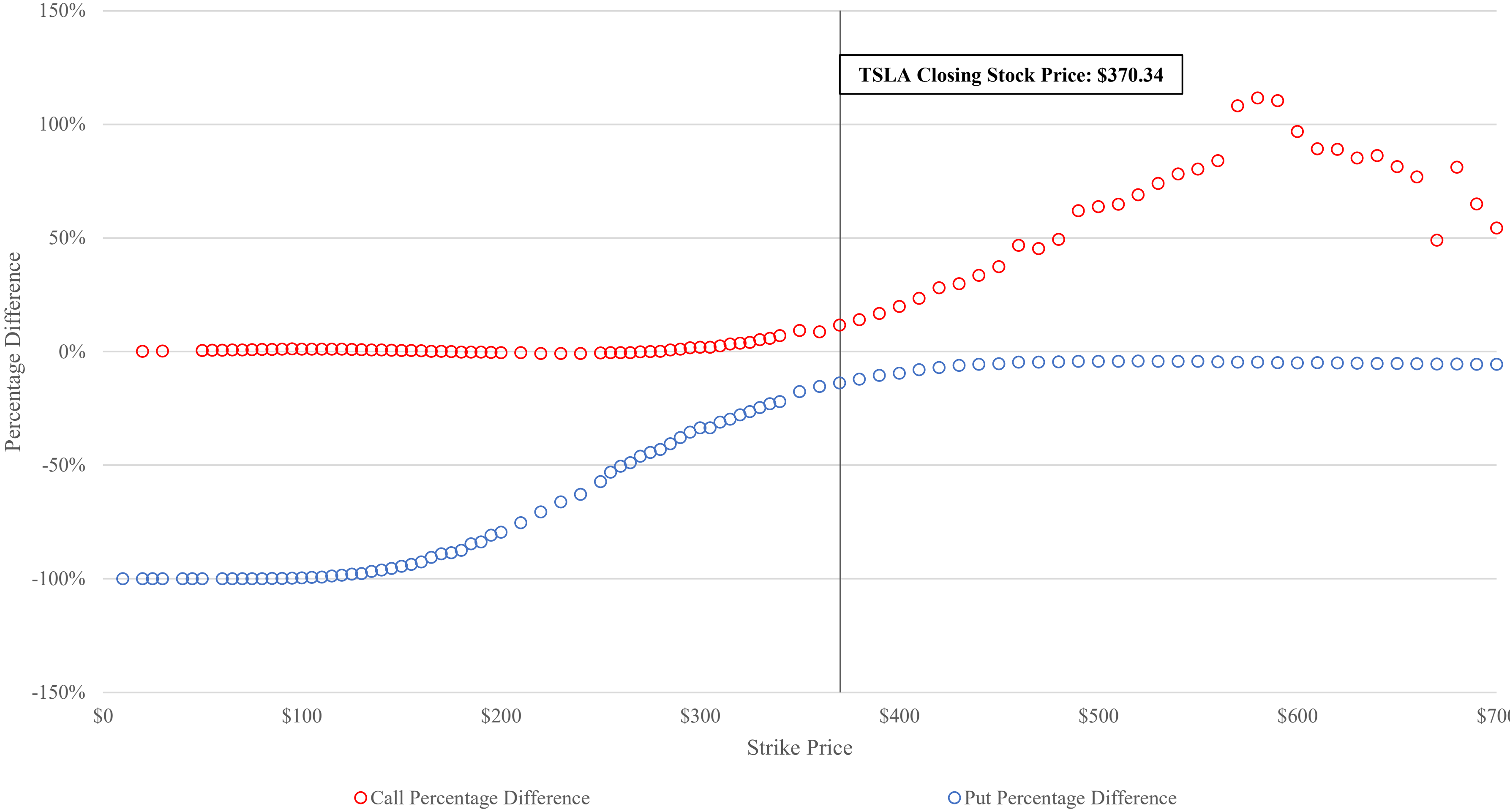


Notes:
1. Model-Based Prices are calculated using Heston Straddle Implied Volatilities and a continuously compounded risk-free rate of 2.43%.
2. Actual Prices are calculated as the average of the bid and ask prices.
3. Pecentage difference is calculated for each option as Model-Based Price/Actual Price - 1.
3. Excludes options for which the bid or ask price are zero and options with zero open interest.
4. Prices are as of 4:00 PM EST.

Sources: CBOE Data, Heston Report.

Exhibit 4

Percentage Difference Between Model-Based and Actual TSLA Option Prices on August 8, 2018 for Options Expiring January 17, 2020

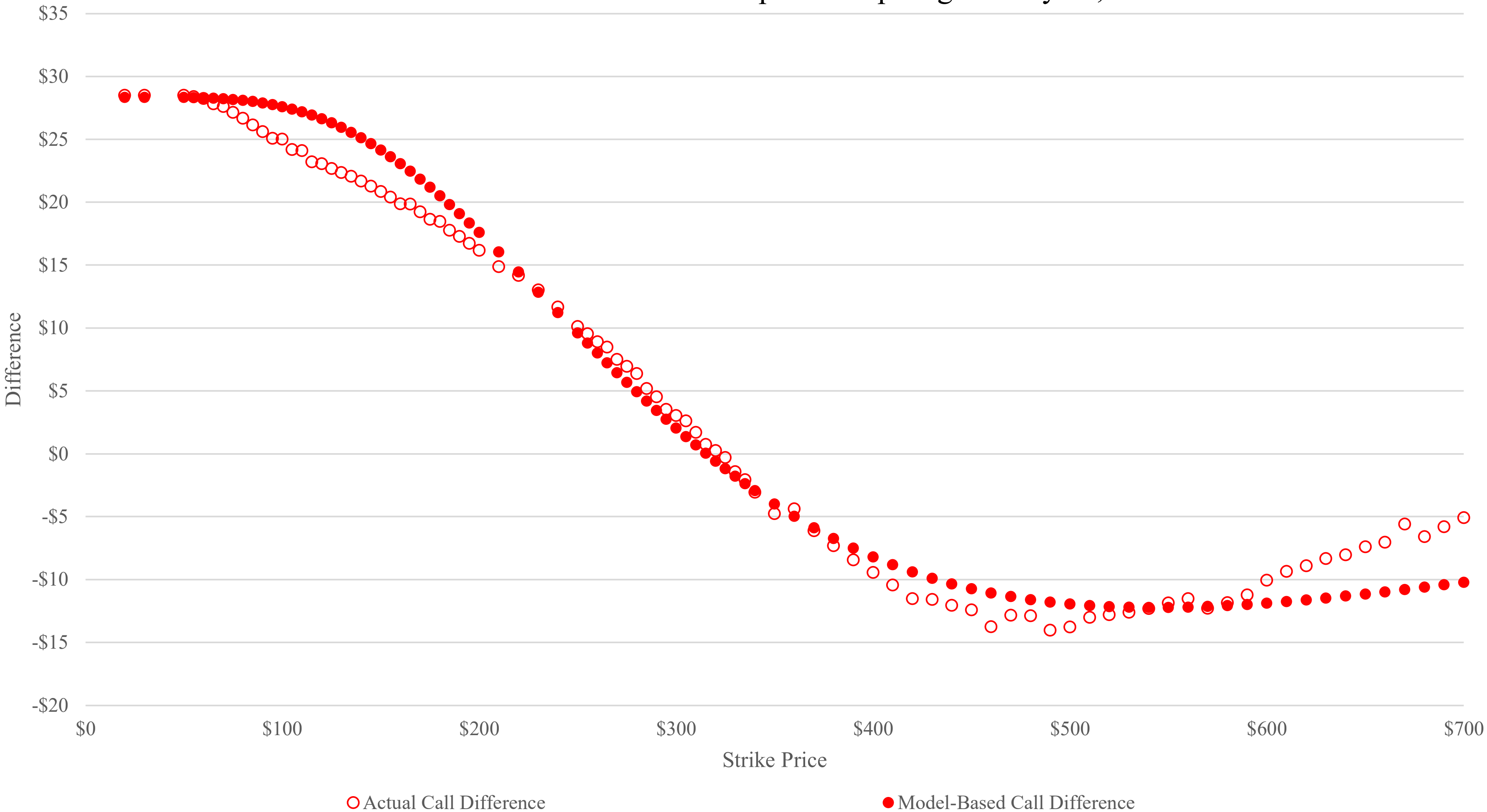


Notes:
1. Model-Based Prices are calculated using Heston Straddle Implied Volatilities and a continuously compounded risk-free rate of 2.43%.
2. Actual Prices are calculated as the average of the bid and ask prices.
3. Pecentage difference is calculated for each option as Model-Based Price/Actual Price - 1.
3. Excludes options for which the bid or ask price are zero and options with zero open interest.
4. Prices are as of 4:00 PM EST.

Sources: CBOE Data, Heston Report.

Exhibit 5A

Difference in TSLA Call Option Prices Between August 6 and August 8, 2018
Model-Based vs. Actual Prices for Options Expiring January 17, 2020

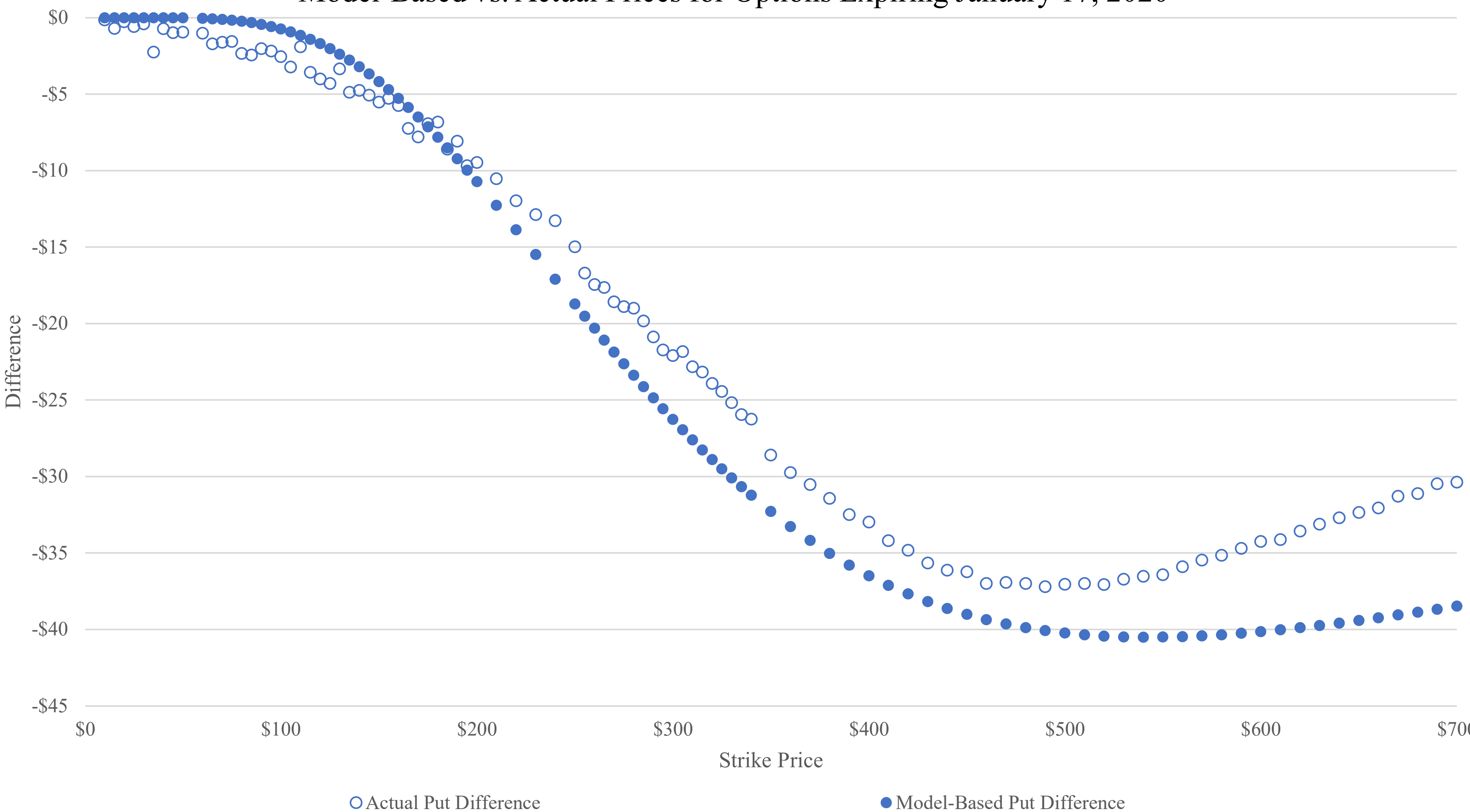


Notes:
1. Model-Based Prices are calculated using Heston Straddle Implied Volatilities and a continuously compounded risk-free rate of 2.43%.
2. Actual Prices are calculated as the average of the bid and ask prices.
3. Difference is calculated as the Actual or Model-Based price on August 8, 2018 minus the Actual or Model-Based price on August 6, 2018.
4. Excludes options for which the bid or ask price are zero and options with zero open interest.
5. Prices are as of 4:00 PM EST.

Sources: CBOE Data, Heston Report.

Exhibit 5B

Difference in TSLA Put Option Prices Between August 6 and August 8, 2018
Model-Based vs. Actual Prices for Options Expiring January 17, 2020



Notes:
1. Model-Based Prices are calculated using Heston Straddle Implied Volatilities and a continuously compounded risk-free rate of 2.43%.
2. Actual Prices are calculated as the average of the bid and ask prices.
3. Difference is calculated as the Actual or Model-Based price on August 8, 2018 minus the Actual or Model-Based price on August 6, 2018.
4. Excludes options for which the bid or ask price are zero and options with zero open interest.
5. Prices are as of 4:00 PM EST.

Sources: CBOE Data, Heston Report.

Exhibit 6

Replication of Dr. Hartzmark's Table 8 Using Heston Implied Volatilities and Put and Call Implied Volatilities for Options with Expiries of January 17, 2020, June 21, 2019 and August 16, 2019

***Panel A**. Heston Implied Volatilities[1] for January 17, 2020 Options*

	8/7/2018	8/8/2018	8/9/2018	8/10/2018	8/13/2018	8/14/2018	8/15/2018	8/16/2018	8/17/2018
[1] Heston Implied Volatility for January 17, 2020 Options	32.57%	37.08%	42.02%	40.43%	38.54%	38.37%	39.96%	40.87%	48.65%
[2] Difference with August 17, 2018	16.08%	11.57%	6.63%	8.22%	10.11%	10.28%	8.69%	7.78%	0.00%
[3] Amount of Difference [2] Relative to August 7 Close Difference	100.00%	71.98%	41.21%	51.14%	62.90%	63.95%	54.02%	48.41%	0.00%
[4] Daily Direct Artificial Inflation based on $23.27 on 8/7/2018	$23.27	$16.75	$9.59	$11.90	$14.64	$14.88	$12.57	$11.27	$0.00

***Panel B**. Heston Implied Volatilities[1] for June 21, 2019 Options*

	8/7/2018	8/8/2018	8/9/2018	8/10/2018	8/13/2018	8/14/2018	8/15/2018	8/16/2018	8/17/2018
[1] Heston Implied Volatility for June 21, 2019 Options	35.71%	38.72%	44.95%	43.88%	42.63%	42.77%	43.52%	43.76%	51.65%
[2] Difference with August 17, 2018	15.94%	12.93%	6.70%	7.77%	9.02%	8.88%	8.13%	7.89%	0.00%
[3] Amount of Difference [2] Relative to August 7 Close Difference	100.00%	81.15%	42.05%	48.75%	56.57%	55.69%	50.99%	49.52%	0.00%
[4] Daily Direct Artificial Inflation based on $23.27 on 8/7/2018	$23.27	$18.88	$9.79	$11.34	$13.16	$12.96	$11.87	$11.52	$0.00
[5] Percentage Difference From Hartzmark Direct Artifical Inflation	0.00%	12.75%	2.04%	-4.68%	-10.07%	-12.92%	-5.61%	2.28%	

***Panel C**. Heston Implied Volatilities[1] for August 16, 2019 Options*

	8/7/2018	8/8/2018	8/9/2018	8/10/2018	8/13/2018	8/14/2018	8/15/2018	8/16/2018	8/17/2018
[1] Heston Implied Volatility for August 16, 2019 Options	34.78%	38.46%	44.73%	43.04%	41.65%	41.90%	42.74%	42.95%	50.88%
[2] Difference with August 17, 2018	16.11%	12.42%	6.16%	7.84%	9.23%	8.99%	8.15%	7.93%	0.00%
[3] Amount of Difference [2] Relative to August 7 Close Difference	100.00%	77.14%	38.22%	48.69%	57.33%	55.81%	50.59%	49.24%	0.00%
[4] Daily Direct Artificial Inflation based on $23.27 on 8/7/2018	$23.27	$17.95	$8.89	$11.33	$13.34	$12.99	$11.77	$11.46	$0.00
[5] Percentage Difference From Hartzmark Direct Artifical Inflation	0.00%	7.17%	-7.26%	-4.80%	-8.86%	-12.73%	-6.36%	1.70%	

Notes:

1. Implied Volatilities are computed using Dr. Heston's at-the-money straddles for different expirations at the end of each date.

Sources: CBOE Data, Hartzmark Report, Heston Report.